

## MP468C — Computational Physics 2 — Lab 08

1. Consider the system of equations

$$\begin{aligned}7x_1 - x_2 + 3x_3 &= -1 \\x_1 + 7x_2 - x_3 &= 2 \\-x_1 + 2x_2 - 5x_3 &= -1\end{aligned}$$

- (a) Set up the iteration equations for solving this system using Jacobi iteration.
  - (b) An iteration routine should have a well-defined termination condition. Discuss possible termination conditions.
  - (c) Code the algorithm using the following termination conditions:
    - i. Accept solution when the norm of the **residual** becomes smaller than  $\epsilon$ .
    - ii. Accept solution when the difference of two successive iterations has smaller norm than  $\epsilon$ .
  - (d) Set up Gauss-Seidel iteration for the same system of equations and code the algorithm.
  - (e) Using the first stop condition above, for  $\epsilon = 10^{-6}$ ,  $\epsilon = 10^{-8}$ , and  $\epsilon = 10^{-10}$ , compare the number of steps required for convergence, for Jacobi and for Gauss-Seidel.
2. Create an  $N \times N$  sparse matrix such that: the diagonal elements all have value  $-2$ ; the elements on the two main subdiagonals all have value  $+1$ ; all the other values are zero.
- (a) List your program's memory usage as a function of  $N$ , showing that your computer can handle matrices larger than  $N \approx 10^4$ , in contrast to full matrices.

- (b) Use scipy's 'eigs' function to compute the smallest and largest eigenvalues, for a couple of different values of  $N$ . Which algorithm is eigs using?